



Status

High Reliability Inverter

Presented by:

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Jointly funded by DOE

Energy Storage Program

DER Electric Systems Integration

Photovoltaics

Contracts Awarded to:

Xantrex, SatCon, GE

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Why This Program Was Needed

- ❑ PV inverters are the most widely implemented DER inverters
- ❑ PV inverters thought to have a MTFF of five years
 - Drives up life-cycle-cost
 - Perpetrates the idea that inverters are untrustworthy
- ❑ PV inverters more mature than other technologies
 - Other technologies very likely to have same problems
- ❑ Quantity of PV inverters is significant (100's of thousands).

Essential features of the Inverter Initiative

- ❑ Boost quantity of inverters sold by developing a common architecture
 - Multiple markets (storage, PV, fuel cells, microturbines)
 - Multiple applications (grid-tied versus off grid)

- ❑ Incorporate new technologies

- ❑ Involve major manufacturer(s) for production
 - have best-business practices in place (ISO, quality & reliability, systems eng)
 - have resources to do job
 - have understanding of and access to mass production

Benefits of this Program

- ❑ Double inverter lifetime to > 10 years
- ❑ Transportable designs for
 - Multiple Technologies (Storage, Photovoltaics, & DER)
 - Multiple power sizes (kW to MW)
- ❑ Advanced designs – fewer components
- ❑ New inverter technologies
 - DSP (digital signal processing)
 - Modular electronics and software
 - Advanced heat flow
- ❑ Expanded markets
- ❑ Increase public confidence



Criteria for Bid Evaluation



- ❑ Corporative Capabilities 20 points
 - Understanding of problem / Business Plan
 - market research (high sales volume essential for high reliability in low cost item)
 - sales & distribution plan
 - long term goal for this product
 - proposed product fit with market and company
 - Resources (people, facilities)
 - Structure (ISO, quality)
- ❑ Technical Proposal 50 points
 - Understanding of causes of low reliability
 - Proposed Architecture
 - fit to DER sources
 - ease of manufacturing
 - portability to other products
 - software modularity
 - Proposed hardware
 - design
 - evidence that the design improves reliability
- ❑ Cost sharing 20 points

Market Research of the Bidders

Company	Metric (#,\$,MW)
Xantrex	63,000 inverters - 2002 152,000 inverters- 2006
SatCon	\$125 M – 2001 \$600 M - 2006
GE	30 MW (US) -2001 100 MW (US) - 2005



Xantrex Corporative Capabilities

☐ Understanding of problem

- market research - **exceptional, reflects PV experience**
- long term goal for this product - PV, fuel cells, wind, storage
- proposed product fit with market and company - **worlds largest manufacturer of photovoltaic inverters**

☐ Resources

- People - **extensive inverter & PV program & design experience.**
- Facilities - adequate

☐ Structure

- ISO - registered
- Quality - in-place

☐ Comment: An experienced PV company that has learned from past experience.

SatCon Corporate Capabilities

☐ Understanding of problem

- market research - very good
- long term goal for this product - single design for PV and fuel cell, tie to energy storage
- proposed product fit with market and company - fits with company business of manufacturing energy management products.

Resources

- People - adequate
- Facilities - extensive

☐ Structure

- ISO - registered
- Quality - in-place

☐ Comment: a fairly new technology company with good experience.

GE Corporate Capabilities

□ Understanding of problem

- market research - the most extensive of all the proposals
- long term goal for this product - distribute systems through their **Home Product and Service** which provides service to new home construction.
- proposed product fit with market and company - already have **extensive UPS business**, anticipate fuel cell work.

Resources

- People - extensive
- Facilities - impressive

□ Structure

- ISO - certified
- Quality - in-place

□ Comment: A very large company with vast technical and financial resources. Will they go the distance????



Cost Sharing

Xantrex	- 56%
GE	- 50%
Satcon	- 50%

Comparison of Approaches

Company	Storage	Control	Heat	Location	Novel idea
Xantrex	optional	DSP	Fan ?	outdoor	Single stage design
SatCon	No	DSP & ASIC	No fan	rooftop	Small parallel power stages
GE	optional	DSP	Fan ?	outdoor	Soft switching

Other Comparisons

Company	Product Distribution	Edge	Other applications	Fit	Size, input V
Xantrex	Exists	80,000 units in the field	Energy storage, Fuel cell after 2006	Core business	2.5/5kw, 48Vdc
SatCon	Team with module makers. Existing distribution network.	Design experience with 70° C operation	Fuel cell, Auto, energy storage	Logical extension of fuel cell product	2 kW, 150-300 Vdc
GE	GE Home Building Distribution, (Capitol Financial)	UPS experience	Energy storage, Fuel cell, UPS	Existing fuel cell, UPS, microturbine, wind	1-10 kW, 240-350 Vdc



Program Schedule (three phase program)

- ☐ Phase One Contracts awarded --- August 21
- ☐ Period of Performance --- 4 months
- ☐ Phase Two RFQ out --- Jan 2003
- ☐ Next Award --- March 2003



Inverter for Voltage Stabilization

Millennium Technologies



Voltage Stabilizer from Millennium Technologies



Program Evolution

- ❑ Issue: A desire to investigate the feasibility of using super-capacitors in place of batteries for certain applications.
- ❑ Opportunity: Honeywell microturbine did not offer seamless transfer. This was a target of opportunity.
- ❑ Original solution: Install super-capacitors on the Honeywell microturbine with upgraded power electronics.
- ❑ Unexpected event: Honeywell quit the business.
- ❑ New Solution: Develop from scratch, an inverter, that could demonstrate the feasibility of using super capacitors in place of batteries.



Program Status

- ☐ Inverter delivered to SNL on Nov 7, 2002.
- ☐ Testing to begin by Nov 18
- ☐ Tests Planned
 - Connect inverter to grid with battery storage and verify manufacturer's test data.
 - Maintain grid voltage by supplying surge current for start of a 20 hp motor with fan
 - Replace batteries with super capacitors and repeat tests
 - Document differences
 - Develop criteria for using super capacitors